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Currency Crisis and Multiple Equilibria: The Role of Co-ordination Failures among Heterogeneous Investors

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Currency crises and multiple equilibria: the role of co-ordination failures among heterogeneous investors

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Abstract

International capital markets are inherently unstable, and may precipitate an unnecessary currency crisis as a result of a failure by differentiated investors to co-ordinate their actions in response to a "mild" fundamental shock. This paper illustrates the point in a simple 3-period model, in which two heterogeneous risk-averse representative investors enter the market at different stages, and a policy-maker who, having to adjust to a current account shock, faces the decision whether or not to devalue the currency. A range of values for the shock is identified over which two equilibria, both rational, coexist. In the "good" equilibrium absence of capital flight and ongoing lending allow an orderly adjustment (no regime switch); in the "bad" one capital flight and the drying up of fresh inflows force the policy-maker to devalue. The short-term nature of capital flows is seen as a crucial determinant of such instability, and the availability of an international lender of last resort is shown to eliminate it.

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SUMMARY

1 Introduction and literature review

The literature on currency and financial crises has received much stimulus by a series of recent episodes, including the devaluation of some ERM currencies in 1992-93 and the more recent crises in Mexico (1994-95) and East Asia (1997-98). In the last 20 years, i.e. since Krugman's 1979 seminal paper, three broad categories of models have been developed of currency crises.

In first generation (fundamentals based) models the hint of Krugman is followed in viewing currency attacks as the result of some inconsistencies in domestic economic policies. A number of extensions has refined Krugman's original contribution[1], but they all share its main message: currency attacks are the necessary outcome of some macro-inconsistencies; the focus, in particular, is in the combination of a fixed exchange rate with domestic credit creation in excess of demand, the blame of which usually falls on the need to finance Government budget deficits. While such models have received some support from the empirical literature, they do not appear to fit too well the most recent episodes, where fundamentals (there including the budgetary position) had not raised any major concerns among most observers, and the attacks appeared, *ex ante*, unjustified[2].

Second generation models, pioneered by Obstfeld (1986a)[3], show how a crisis may erupt even in the absence of weak fundamentals, simply because it is expected to occur. This may happen because defending the peg is costly to the economy (in terms, for example, of high interest rates and subsequently larger unemployment). Introducing Government preferences explicitly into the analysis generates the possibility of self-fulfilling crises. Agents' devaluation expectations may drive the mentioned costs so high to force the Government to devalue; on the other hand, if agents do not expect a devaluation and those costs are absent, then the fixed exchange rate regime proves sustainable. Self-fulfilling models have been blamed for not providing an economically meaningful solution to the issue of what determines the expectational shift which, given indeterminacy, is necessary to trigger a regime switch[4].

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[1] See Agenor and Flood (1994) for a survey, Flood and Garber (1984), Obstfeld (1984 and 1986b) and Willman (1988a and 1988b).

[2] Examples of empirical studies on the subject are Blanco and Garber (1986), Eichengreen, Rose and Wyplosz (1996) and Goldberg (1994).

[3] See also: Obstfeld (1994 and 1996), Ozkan and Sutherland (1994), Davies and Vines (1995), Jeanne and Masson (1998); for challenges to the multiple equilibria hypothesis see Krugman (1996) and Morris and Shin (1998); empirical evidence can be found, for example, in Eichengreen and Wyplosz (1993) and Jeanne (1997).

[4] See, however, Krugman (1991), Davies and Vines (1994) and Sachs (1995).

A third, more recent, view raises the issue of moral hazard, which may dominate domestic investment decisions if Government cannot credibly commit not to bail out a disrupted financial sector in the event of a major crisis. Financial intermediaries may thus be led to invest in overly risky assets, with resulting weakening of the system as a whole. The blame is again on the Government, who accumulates contingent liabilities, bound to show up in the taxpayers' bill (including the possibility of reliance on the inflationary tax), in the event of a major negative shock[5]. The moral hazard hypothesis is not new in the literature[6], but it does not give a fully satisfactorily account of what happened, for example, in Asia: as noted by Radelet and Sachs (1998), all types of foreign investment appear to have neglected any supposed deterioration in the overall risk and efficiency profile, including (for example) equity and real estate investments, which are unlikely to rely on any form of *ex post* bail out[7].

The above accounts do little justice to the problem of international capital market instability, which often appears to be the natural outcome of an increasingly globalised and unrestricted international financial system, rather than of poor macro- or microeconomic management. This is true *a fortiori* if one acknowledges the advances recorded in the literature on asymmetric information and credit rationing[8]. If capital markets do not clear, and the terms of international borrowing are governed by the supply side, then the causes of instability might have to be looked for in the interactions and externalities proper of investors' behaviour, especially with respect to their attitude towards the returns and risks involved in international lending. The part of the literature which responds most closely to these concerns is that coming out of the Diamond and Dyvbig (1983) contribution to the banks run tradition[9]. Diamond and Dyvbig show how failure of different lenders to co-ordinate may turn a borrower's (temporary) liquidity shortage into insolvency, by forcing her to early and inefficient liquidation of long term profitable assets. Although in Diamond and Dyvbig the focus is on destruction of physical value, the idea is easily extended to the financial sector, where the grab is rather on foreign

[5] See Velasco (1987) for a model of the experience of Chile, Argentina and Uruguay at the beginning of the 80s; McKinnon and Pill (1996), who coined the term "overborrowing syndrome"; Burnside, Eichenbaum and Rebelo (1998) and Krugman (1998) for models inspired by the recent Asian experience.
[6] See Diaz-Alejandro (1985), who discusses the issue with respect to the Chilean crisis; see also Edwards (1984 and 1996), who also deals with the cases of Argentina and Uruguay.
[7] Krugman (1999) also acknowledges Radelet and Sachs' concerns.
[8] Pioneers in the field are Stiglitz and Weiss (1981).
[9] See, among others, Sachs, Tornell and Velasco (1996) with respect to Mexico, Radelet and Sachs (1998) with respect to East Asia. For a formal model, see Chang and Velasco (1998).

currency, and investors fear shortage of foreign exchange and currency losses[10]. This view seem to fit some empirical regularities, notably: the large increase in short term foreign liabilities and the growing imbalance between market liquidity and foreign exchange reserves which are observed in the lead up to crises; the fact that capital flight appears to follow the drying up of new lending; the significance of debt maturity and financial liberalisation as predictors of balance of payments crises[11].

Another series of contributions linking financial crises to some form of capital market imperfections derives from the work on the credit channel and the financial accelerator[12]. In these models, credit amplifies the consequences of a shock by behaving procyclically, as a consequence of the cyclical evolution of the value of collateral assets. For example, Edison, Luangaram and Miller (2000) build a model, based on Kiyotaki and Moore (1997), in which financial collapse results from a credit crunch, which forces a massive sale of assets by credit constrained financial companies and is reinforced by the subsequent deflation[13]. Aghion, Bacchetta and Banerjee (1999) investigate the role of imperfect credit markets and capital mobility in generating instability in small open economies.

The internationalisation of capital markets has long been recognised an opportunity for improvement of the risk-return profile of investors' portfolios; the results in this area of modern finance build on the assumption that investors are risk averse, and assets in different Countries are imperfect substitutes for each other. In such a world, capital flows are the result of a stock adjustment[14]. Yet, the literature on currency crises has tended to deny relevance to the issue of portfolio optimisation and risk aversion, so that the supply side of the market is rarely modelled explicitly, being replaced by the doubtful uncovered interest parity relationship. Another point which also would deserve more attention is the time dimension of stock adjustment; adjustment is not instantaneous, and this could result from adjustment costs or some form of heterogeneity among investors.

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[10] This is not to say, however, that the original spirit in Diamond and Divbig does not capture some important facts in recent crises, like the overly sharp real contraction to which the crisis economies have been forced.

[11] See Kaminsky, Lizondo and Reinhart (1996) and Sachs, Tornell and Velasco (1996).

[12] See, for example, Bernanke and Gertler (1995) and Bernanke, Gertler and Gilchrist (1998). and Aghion, Bacchetta and Banerjee (1999).

[13] The model is especially suited to characterising the crisis in Thailand, where a bubble in land prices and overexposure of domestic financial intermediaries were an important source of instability and a precondition for financial collapse.

[14] See Dornbusch (1983), Edwards (1984) and Brainard and Tobin (1992).

The transfer problem is another important issue often overlooked, and this also derives, partly, from the above deficiencies. The transfer problem arises when the domestic balance (between demand and supply) and the external trade balance need to adjust to match a reduction in capital flows[15]. The issue becomes crucial, in particular, when capital flows are viewed as a temporary phenomenon (the portfolio approach), and the recipient Country runs a current account deficit: when portfolio adjustment comes to an end, then policies aimed at restoring current balance need to be implemented. This perspective may have significant consequences on the behaviour of investors, who may fear adjustment eventually to be achieved by means of exchange rate depreciation.

The simple model I develop in the next section is in an attempt at filling the above mentioned gaps and a contribution to the interpretation of recent crisis episodes in Mexico and East Asia, from which the present work has taken inspiration. Anticipating the main results, I show how a Country with a large stock of short term liabilities may be vulnerable to capital markets instability, in the sense that the eventual inability of different categories of investors to co-ordinate their actions in response to a "mild" fundamental shock triggers a crisis which the shock, by itself, would otherwise have not caused (this is the sense in which the shock is mild).

2 The model

There are three periods (denoted by 0, 1 and 2) and three agents: a policymaker (the domestic Government) and two representative investors (denoted by I_0 and I_1).

The Government is assumed to minimise a loss function (L) which depends on deviations of output and real exchange rate given desired levels. The target for output ($\underline{Y}$) is the natural level; the target for the real exchange rate ($\underline{s}$) is the level which balances the expected current account, as calculated later (see equation 5). The Government fixes the exchange rate at the desired level, at the beginning of period 0, and she is assumed to bear a fixed cost in the event of a regime switch (i.e. either a devaluation or an appreciation). The loss function is specified as follows:

$$L = (Y_t - \underline{Y})^2 + z(s_t - \underline{s})^2 + dC^2 \qquad (1)$$

[15] An exaustive discussion of the transfer problem is offered by Reisen and van Troetsenburg (1988).

where t = 0,1,2; Y_t is period t output; s_t is the real exchange rate at t; C^2 is the regime switch fixed cost (d is a dummy variable which takes on the value 0 if the exchange rate is not changed, and 1 in case of either devaluation or revaluation); z is a positive weight parameter, indicating the bias in Government's preferences towards real exchange rate relative to output deviations from target.

The choice of the variables included in the loss function is rationalised as follows. Output deviations generate (political) costs in terms of excessive unemployment if output is below its natural level, or inflationary pressure if it is above (Barro and Gordon, 1983). Real exchange rate deviations from equilibrium create distortions in incentives to production of tradeables relative to non tradeables; furthermore, if prices are rigid, Government may be concerned with the impact of a nominal devaluation on the level of real wages, and the distribution of wealth in the economy (for this argument, see Dornbusch, 1980). The fixed cost captures the costs associated to the loss of credibility, which follows the failure of a fixed exchange rate policy; such costs include the inflationary bias suffered by an economy when economic policy is dynamically inconsistent (Barro and Gordon, 1983)[16].

The two representative investors can hold domestic (peso) and foreign (dollar) interest bearing assets. Peso nominal and real returns are denoted, respectively, by r and i; the corresponding for dollar assets are denoted by r^* and i^*. Investors are endowed with a given wealth w (of which a fraction π is held by I_0, and the rest by I_1), initially invested in dollar assets.

Their choices with respect to asset holdings result from optimisation of a risk averse utility function as will be explained later. Demands for peso assets by I_0 and I_1 in period t are denoted, respectively, by K_0^t and K_1^t, and will depend on relative (peso vs dollar) returns and on their variability.

It is assumed that I_0 only enters the market in period 0, while I_1 enters in period 1. The introduction of two different types of investors, and the timing of their actions, reflect the view of capital inflows as a stock adjustment phenomenon[17]. I_0 and I_1's unsynchronised

[16] Giavazzi and Pagano (1988) show how a Government can take advantage from credibly restricting the set of available policy options, when this affects agents' expectations and their behaviour.

[17] See Brainard and Tobin (1992) and Edwards (1984). Edwards illustrates how interpreting capital flows as an asset adjustment phenomenon may lead to their short run overshooting and shows the consequences for sustainability of an overly appreciated real exchange rate.

actions capture the graduality in adjustment to equilibrium. Different explanations for such graduality might be given, including the existence of adjustment costs and heterogeneity in information sets among different investors. Here it is assumed that I_0 and I_1 have different access to available information about the domestic economy; in particular, I_0 is assumed to be better informed (hence she can exploit improved prospects for the domestic economy earlier), while I_1 has a lagged access to such information (or maybe she just infers it from the behaviour of I_0). I_0 are called "pioneers" and I_1 "late investors", and K_1^0 is restricted to be 0. At the beginning of period 1, I_0 eventually readjusts her portfolio (this happens if $K_0^1 \neq K_0^0$), according to newly available information; this includes, in particular, as will be formalised later, the realisation of a shock to the current account in period 0.

The sequencing of actions may then be summarised as follows. After the exchange rate has been fixed, I_0 enters the domestic market and acquires K_0^0 peso assets; subsequently, a shock hits the current account; at the beginning of period 1, after observing period 0 shock, I_1 invests K_1^1 in peso assets and I_0 adjusts her portfolio by (K_0^1 - K_0^0). Afterwards, period 1 shock to the current account is realised.

Remember that, by assumption, both had no peso assets to start with.

The current account is assumed to be a linear function of the real exchange rate (s), the level of real income Y and a random autonomous component X. The equation for the current account in period t is:

$$CA_t = X_t + \beta s_t - \gamma Y_t \qquad (2)$$

where β and γ are positive parameters (the standard conditions for the positive effect of a real devaluation on the trade balance are taken to apply).

The autonomous component at time t is assumed to be the sum of its previous period value and an independently and identically distributed zero mean random shock (ε_t), whose distribution function is known to agents. The expected value for the period zero autonomous component is $\underline{X}$, so that we have:

$$X_0 = \underline{X} + \varepsilon_0$$

$$X_t = X_{t-1} + \varepsilon_t \qquad t = 1,2 \qquad \varepsilon_2 = 0 \qquad (3)$$

where $\varepsilon_t \sim iid(0, \sigma_\varepsilon^2)$.

At time 0 the authorities set s at the level $\underline{s}$ such that the expected period 0 current account is in balance, i.e. such that:

$$E(CA_0) = \underline{X} + \beta s_0 - \gamma \underline{Y} = 0 \qquad (4)$$

$\underline{s}$ thus is given by: $s_0 = \underline{s} = \frac{\gamma}{\beta}\underline{Y} - \frac{1}{\beta}\underline{X}$ (5)

Period 2, rather than being the last period in life for the representative agents, when everything is consumed and debts have to be repaid, is represents the idea of a steady state in an infinite horizon framework, where agents keep their financial wealth optimally invested and eventually consume the return it yields. This is meant to capture the idea of a series of investors, flowing in and out of the domestic Country[18], which can in principle rely indefinitely on a steady (non exploding) level of foreign savings to finance her own investment and consumption needs. Hence we can think of periods 2 up to infinity as collapsing into one single time point (period 2). From the interpretation of t = 2 as a steady state follows having set $\varepsilon_2 = 0$.

What is required in period 2 is that the current account be in balance, which is the equivalent of the intertemporal constraint that an open economy faces in standard optimising models, as no repayment of principal is to be done. If any shocks affect the current account in early periods and generate an unbalanced position (say a deficit), then in period 2 the Government will have to engineer a riequilibration. This can be done by either depreciating the real exchange rate or by deflating domestic output, or by a combination of devaluation and deflation. It is assumed that the authorities can manipulate real output (by means of standard fiscal policy instruments[19]) and the real exchange rate in

[18] Sen (1994) develops an overlapping generations, infinite horizon model with new births, where the ricardian equivalence is shown to break down if no altruistic behaviour is assumed. The idea of new births is very much analogous, analytically, to that of heterogeneous investors expressed in this discussion.

[19] It can be assumed that real output is demand determined, so that the Government can control it by controlling public sector consumption and investment demand.

the desired way[20]. The choice of the adjustment policy is eventually determined by Government preferences as expressed in the loss function L. Having to achieve the current account balance, output and real exchange rate at t = 2 have to satisfy the following constraint:

$$CA_2 = X_2 + \beta s_2 - \gamma Y_2 = 0 \qquad (6)$$

which implies

$$s_2 = \frac{\gamma}{\beta} Y_2 - \frac{1}{\beta} X_2 \qquad (7)$$

2.1 The behaviour of the Government

Government's behaviour in period 2 is best analysed by first assuming the fixed cost away, which means that she has no concern for credibility. Hence dC^2 is momentarily dropped from the loss function. The Government then has to minimise the following loss function $L_2^{'}$ subject to (7):

$$Min\left\{L_2^{'} = \left(Y_2 - \underline{Y}\right)^2 + z\left(s_2 - \underline{s}\right)^2\right\}$$

s.t. $s_2 = \frac{\gamma}{\beta} Y_2 - \frac{1}{\beta} X_2$

[20] This is a much more unrealistic assumption. It is meant to resemble the analogous assumption made elsewhere in the literature (for exampe in Davies and Vines, 1995), with the understanding of it being an expositional device, rather than a representation of reality. In the real world, the exchange rate is the relative price of two assets, and as such is to be determined by the corresponding demands and supplies. One possible justification of this assumption is the imperfect indexation of wages and prices to the exchange rate, so that a nominal devaluation entails some real devaluation. However, it will also be assumed that the Government fully sterilizes intervention in the foreign exchange market, so that in the period when the exchange rate is kept fixed the supply of peso assets will perfectly match the swings in demand. This also allows to abstract from the determination of the peso interest rate (the dollar rate is anyway assumed constant) and its variability, and to concentrate on the issue of exchange rate risk, which is the focus of the discussion. Of course, assuming that the Government can engineer a real devaluation implies, in a portfolio balance context, that she issues or retires bonds from the market, which inevitably alters the conditions in the money market and the equilibrium interest rate. But the argument about the possibility of an unnecessary financial panic will be developed under the drastic assumption that, if a devaluation is expected to occur currently, investors leave the market to avoid an instantaneous capital loss.

In what follows, Y_2^* and s_2^* denote the optimal solutions for the output and real exchange rate levels. (7) can be substituted into $L_2^{'}$ for s_2, to obtain:

$$L_2^{'} = (Y_t - \underline{Y})^2 + z\left(\frac{\gamma}{\beta}Y_2 - \frac{1}{\beta}X_2 - \underline{s}\right)^2 \qquad (8)$$

The first order condition with respect to Y_2 is[21]:

$$\frac{\partial L_2^{'}}{\partial Y_2} = 2(Y_2 - \underline{Y}) + 2z\left(\frac{\gamma}{\beta}Y_2 - \frac{1}{\beta}X_2 - \underline{s}\right)\frac{\gamma}{\beta} = 0 \qquad (9)$$

Rearranging (9) yields:

$$Y_2^* = \frac{\gamma z}{\beta^2 + \gamma^2 z}(X_2 + \beta \underline{s}) + \frac{\beta^2}{\beta^2 + \gamma^2 z}\underline{Y} \qquad (10)$$

Substituting (5) into (10) gives:

$$Y_2^* = \frac{\gamma z}{\beta^2 + \gamma^2 z}(X_2 - \underline{X}) + \underline{Y} \qquad (11)$$

It easy to check that the second order condition is satisfied at $Y = Y_2^*$. Given the assumed parameter signs, the loss function is convex in Y_2, and the second order derivative with respect to Y_2 is always positive, which is the condition for a minimum:

$$\frac{\partial^2 L_2^{'}}{\partial {Y_2}^2} = 2Y_2 + 2z\frac{\gamma^2}{\beta^2}Y_2 > 0$$

$\forall\ Y_2 > 0$

[21] Both output and real exchange rate are instruments suitable for minimization, as they have been assumed to be both under the authorities' control. Here minimization is worked out with respect to Y_2, and the adjustment constraint (7) is substituted for s_2 into the objective function.

Y_2^* is the level of Y_2 which the authorities would choose if they have to adjust in period 2, as a function of (X_2 - $\underline{X}$). Note that (X_2 - $\underline{X}$) is nothing but the value of the cumulative shocks in the three periods, i.e.: (X_2 - $\underline{X}$) = ($\varepsilon_0 + \varepsilon_1$), and is the level of the current account in period 2.

The optimal Y_2^* is increasing in the level of the cumulative shocks. This is simply because the larger the (positive) shocks to the current account or, equivalently, the autonomous component X_2, the larger the level of Y_2 compatible with current account equilibrium (more imports, which depend positively on income, are allowed). Clearly, if no shocks occur (or they exactly sum up to zero), in which case $X_2 = \underline{X}$, then $Y_2^*=\underline{Y}$, i.e. no adjustment to $\underline{Y}$ is necessary, being the initial output level compatible with current balance at the initial level $\underline{X}$.

Y_2^* is also increasing in the value of the parameter z. This has the obvious interpretation that the larger the importance the authorities attach to exchange rate deviations from target, relative to output deviations from the natural level (i.e. the larger z), the more of the required current account adjustment will be born by output.

It should be remembered that Y_2^* is found by assuming away any fixed credibility costs associated with an exchange rate devaluation; hence, however small the (absolute) size of the (say negative) cumulative shocks, adjustment will be achieved by a combination of output deflation and real exchange rate depreciation. The optimal level of the real exchange rate is found by substituting (16) for Y_2^* into the adjustment constraint (9), which has been imposed on top of the optimisation program, and thus relates Y_2 and s_2 also at the optimum. After substituting, we obtain:

$$s_2^* = \frac{\gamma}{\beta} Y_2^* - \frac{1}{\beta} X_2 = \frac{\gamma}{\beta} \underline{Y} + \frac{\gamma^2 z}{\beta(\beta^2 + \gamma^2 z)} (X_2 - \underline{X}) - \frac{1}{\beta} X_2 =$$

$$= \frac{\gamma}{\beta} \underline{Y} + \frac{\gamma^2 z - \beta^2 - \gamma^2 z}{\beta(\beta^2 + \gamma^2 z)} X_2 - \frac{\gamma^2 z}{\beta(\beta^2 + \gamma^2 z)} \underline{X} = \qquad (12)$$

$$= \frac{\gamma}{\beta} \underline{Y} - \frac{\beta}{\beta^2 + \gamma^2 z} X_2 - \frac{\gamma^2 z}{\beta(\beta^2 + \gamma^2 z)} \underline{X}$$

The optimal devaluation (revaluation, if negative) is found by subtracting the expression for the fixed exchange rate s from (12):

$$\left(s_2^* - \underline{s}\right) = \frac{\gamma}{\beta}\underline{Y} - \frac{\beta}{\beta^2 + \gamma^2 z} X_2 - \frac{\gamma^2 z}{\beta\left(\beta^2 + \gamma^2 z\right)}\underline{X} - \frac{\gamma}{\beta}\underline{Y} + \frac{1}{\beta}\underline{X} = \tag{13}$$

$$= -\frac{\beta}{\beta^2 + \gamma^2 z}\left(X_2 - \underline{X}\right)$$

As for optimal output, it is straightforward to see that if no shocks cumulate on the current account, i.e. $(X_2 - \underline{X}) = 0$, then no devaluation is required, because the initial (fixed) exchange rate is perfectly compatible with balanced current account (indeed it has initially been set so as to achieve balance).

It should be noted that the authorities could use some of the foreign reserves accumulated up to period 2 in order to finance part of the current account deficit and reduce the required adjustment. In principle, however, adjustment can only be postponed[22], because reserves are limited and the deficit is not reverting to equilibrium (this is a consequence of the assumption about the process generating the autonomous component X_t). The assumption that the entire adjustment is carried out at the beginning of period 2 can be rationalised as a consequence of investors' concern about aggregate liquidity measures such as the quick ratio (i.e. the ratio of short term external liabilities to foreign reserves); the authorities may then aim at keeping the level of reserves from falling to levels that could render the system vulnerable to a panic-led crisis.

So far, the optimal Government's choice about the size of deflation and devaluation has been derived absent any concern for the credibility costs of a regime switch. The optimal response to cumulative shocks, however small they are, has been found to be a combination of deflation and devaluation.

Intuitively, however, once the fixed credibility cost of devaluation (C^2) is reintroduced in the loss function, there will be a range of values (centred around zero) for the cumulative shocks ($\varepsilon_0 + \varepsilon_1$), for which achieving the above trade off between deflation and devaluation yields lower welfare than keeping the exchange rate unaltered and letting the adjustment being born entirely by output. The latter option implies an additional loss, which the Government suffers relative to achieving the optimal trade off between deflation and devaluation; such additional loss is zero in the limit, as the size of the cumulative shock tends to zero. The inclusion of a strictly positive fixed cost will then reverse Government's judgement, for a sufficiently small required adjustment, i.e. for small absolute values of the cumulative shocks.

When regime switch is costly, the choice of devaluing becomes discrete: for a sufficiently small required adjustment, no devaluation will be allowed, being the additional costs of a regime switch (i.e. the fixed cost) larger than the corresponding benefits (given by the possibility to trade off deflation and devaluation optimally). In order to identify the critical size of the cumulative shocks which triggers the decision to devalue, the policy loss with and without devaluation need to be compared.

If the Government decides not to devalue, so that adjustment is born entirely by output, then the equilibrating level of Y_2 can be found by substituting $\underline{s}$ (the unchanged real exchange rate) for s_2 in the adjustment constraint (9), which has to be satisfied in equilibrium. The resulting output level is given by:

$$Y_2^n = \underline{Y} + \frac{1}{\gamma}\left(X_2 - \underline{X}\right) \qquad (14)$$

The associated welfare loss (L^n) is calculated by substituting (14) for Y_2 in the loss function L (obviously keeping $s_2 = \underline{s}$), with the dummy variable d taking value zero (i.e. no devaluation):

$$L_2^n = \left[\underline{Y} + \frac{1}{\gamma}\left(X_2 - \underline{X}\right) - \underline{Y}\right]^2 + z\left(\underline{s} - \underline{s}\right)^2 = \frac{1}{\gamma^2}\left(X_2 - \underline{X}\right)^2 \qquad (15)$$

(15) has to be compared to the loss which obtains when output and the real exchange rate are set optimally according to rules (11) and (12) and the fixed cost is added. In this case welfare loss (denoted by L_2^d) is equivalent to:

[22] Recall that period 2 is viewed as the collapse of infinite periods, from 2 up to infinity.

$$L_2^d = C^2 + \frac{(\gamma z)^2}{(\beta^2 + \gamma^2 z)^2}(X_2 - \underline{X})^2 + \frac{z\beta^2}{(\beta^2 + \gamma^2 z)^2}(X_2 - \underline{X})^2 \qquad (16)$$

The regime switch (i.e. the choice to devalue) will occur if the cumulative shocks (X_2 - $\underline{X}$) is sufficiently large that the welfare loss associated to devaluing (L_2^d) is smaller than the loss associated with the adjustment being born entirely by output deflation (L^n). Hence, the condition for devaluation is that $L^d < L^n$, i.e.:

$$C^2 + \frac{(\gamma z)^2}{(\beta^2 + \gamma^2 z)^2}(X_2 - \underline{X})^2 + \frac{z\beta^2}{(\beta^2 + \gamma^2 z)^2}(X_2 - \underline{X})^2 \leq \frac{1}{\gamma^2}(X_2 - \underline{X})^2 \qquad (17)$$

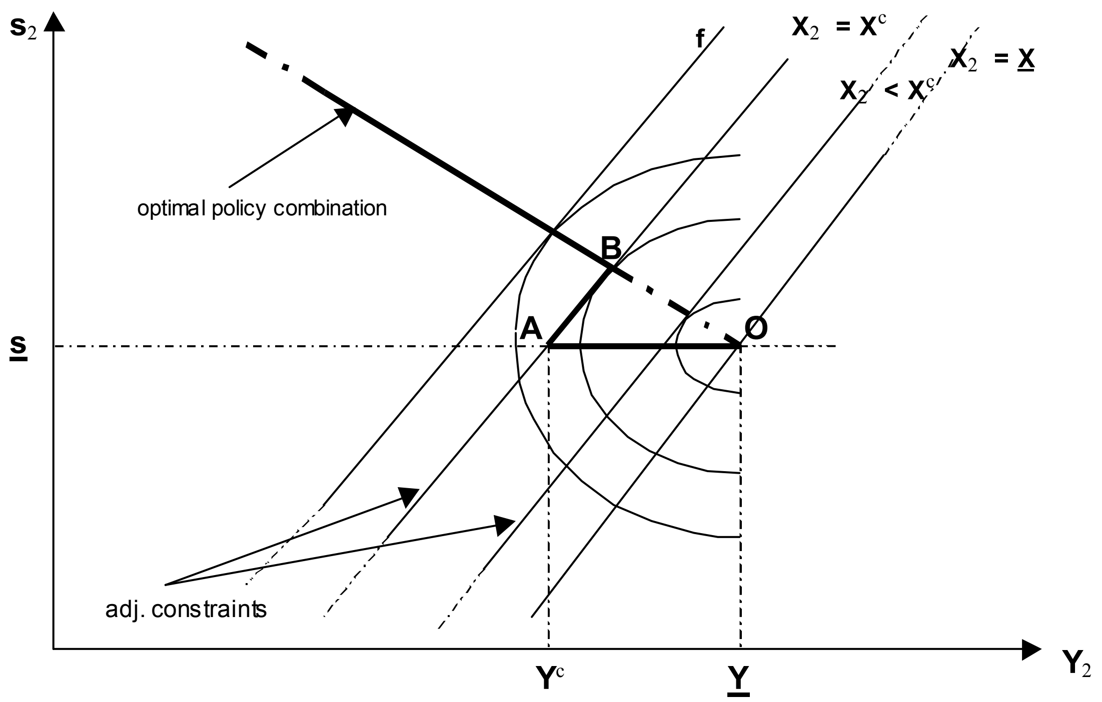
Inequality (17), may be rearranged as follows:

$$(X_2 - \underline{X})^2 \geq \frac{\gamma^2}{\beta^2} C^2 (\beta^2 + \gamma^2 z) \Leftrightarrow |X_2 - \underline{X}| \geq \frac{\gamma}{\beta} C \sqrt{\beta^2 + \gamma^2 z} \qquad (18)$$

(18) is a condition on the size of the cumulative shock. As intuitively discussed previously, (18) defines an interval around zero for the cumulative shocks, outside which devaluation is optimal; correspondingly, sticking to the fixed exchange rate regime is welfare superior for the Government if the cumulative shocks shock are sufficiently small (in absolute value) to be within the critical range.

The situation depicted so far can be represented graphically as in figure 1. Here attention is focussed on the case of negative current account shocks.

FIGURE 1



The circular lines are the iso-loss loci; a larger welfare loss corresponds to loci which are further from point O. Point O is the initial state, where the economy enjoys full employment and the real exchange rate is fixed at the level which equilibrates the current account.

The positively sloped lines represent the adjustment constraints. From the previous analysis it emerged that, in order to adjust to given cumulative shocks, a trade off exists between exchange rate and output management, so that the same adjustment can be achieved by different combinations of output deflation and exchange rate devaluation. The adjustment lines are located further to the left (meaning a larger adjustment need), the lower is the realisation of the cumulative shocks.

The negatively sloped line is the optimal trade off for the Government, going through point O; it says how the Government wishes to move away from the zero loss point O if forced to do so. The first segment of this locus is broken because for sufficiently low (absolute) value of the shock it is optimal not to alter the real exchange rate, and to manipulate only the level of output. This resulted from the comparison of the welfare losses associated to adjustment with and without devaluation. Hence, that segment is replaced by the portion of the horizontal line through O, between $\underline{Y}$ and Y^c, where Y^c is the cut-off output level at which devaluing becomes optimal. Y^c can be found by first calculating the corresponding cut-off value for X^c, i.e. the value of X_2 at which (17) is satisfied with strict equality. Focussing on the case of negative shocks, the cut-off value is given by:

$$X^c = \underline{X} - \frac{\gamma}{\beta} C\sqrt{\beta^2 + \gamma^2 z} \qquad (19)$$

This value can be substituted for X_2 into the expression for the optimal output level under no devaluation, i.e. into equation (14), to obtain Y^c:

$$Y^c = \underline{Y} - \frac{C}{\beta}\sqrt{\beta^2 + \gamma^2 z} \qquad (20)$$

The previous analysis has shown the intuitive result that the decision whether or not to devalue depends on the size of the fixed credibility cost and on the relative importance of output and exchange rate deviations in the Government loss function (the weight parameter z). The larger z and C, the larger (in absolute value) the size of the cumulative shocks must be to trigger a regime switch. This is what (19) says.

Expected time 2 devaluation is thus given by the probability that the cumulative shocks exceed the cut-off level times the conditional size of devaluation, given by (13). The behaviour of rational investors will depend on the conjectured response of the Government to the shocks and to each other's actions as well.

It is important to note that commitment to the peg, and the economic and political costs that follow reneging on it, introduce an important bias into foreign investors' decisions when they optimise their portfolios. We have seen that the existence of a fixed cost affects the Government's attitude with respect to the policy mix (deflation vs devaluation) she faces when adjustment has to be engineered. It has been shown that for sufficiently small shocks it is optimal for the Government to keep the exchange rate fixed. This is equivalent to a truncation of the density function which exchange rate movements would have otherwise, in the sense that zero probability is now attached to small devaluations (corresponding to small shocks). The result is that the variance of period 2 exchange rate is smaller in the presence of the fixed cost than if the exchange rate instrument could be used costlessly. Thus, a fixed exchange rate regime provides an implicit insurance, both to borrowers and lenders, who are eventually led to borrow/lend more than in a flexible rate regime. The overborrowing/overlending effects of a fixed rate regime are often quoted in the literature on financial crisis[23], which stresses how fixed exchange regimes may result in currency mismatch and render the recipient economy subject to sudden and sharp exchange rate corrections.

2.2 The behaviour of investors

So far the analysis has taken the behaviour of foreign investors as given. However, their behaviour may crucially affect the outcome, and the argument can be made that even if a small shock is realised, which would not otherwise trigger any devaluation, a devaluation may be precipitated by investors' panic. For illustrative purposes, a simple expression for the demand for peso assets is derived, following Dornbusch (1983).

In the following discussion, the concept of Nash equilibrium is adopted; in particular, the behaviour of pioneers and prospective investors is an equilibrium if the action of either is the best response to the action of the other.

Investors are endowed with a given level of financial wealth (w). Their utility function depends on the expected value and the variance of end of period wealth.

Utility is defined as:

$$U(E(w),V(w)) \qquad (21)$$

where:

$E(w) = w(1 + E(i^*)) + xw(E(i) - E(i^*))$ is the expected end of period wealth;

x is the share of wealth invested in domestic (peso) assets, and i and i^* are the real returns on domestic (peso) and foreign assets[24];

[23] See, among others, Alba et al. (1998).
[24] Real returns are defined as nominal returns minus expected currency devaluation.

$V(w) = w^2[(1 - x)^2V(i^*) + x^2 V(i) + 2x(1 - x)V(i^*,i)]$ is the variance of end of period wealth, with $V(i^*)$, $V(i)$ and $V(i^*,i)$, respectively, the variance of i^*, the variance of i and their covariance.

Maximising (21) with respect to x yields, after substituting the expressions for expected value and variance of end of period wealth, the following expression for the optimal share of peso assets x_t^*:

$$x_t^* = \frac{E(i_t) - E(i_t^*)}{\theta[V_t(i^*) + V_t(i) - V_t(i^*,i)]} + \frac{V_t(i^*) - V_t(i^*,i)}{[V_t(i^*) + V_t(i) - V_t(i^*,i)]} \qquad (22)$$

where θ is the coefficient of risk aversion, i.e $\theta = -U_1/(U_2w)$ and U_1 and U_2 are the derivative of utility with respect to its first and second arguments.

In (22), θ a constant. However, risk aversion is likely to be endogenous to market developments; in particular, it may behave procyclically, in the sense that it falls when the market is booming and rises when the market stagnates. The issue of destabilising market competition, raised by Taylor (1998) and discussed in previous sections, is helpful in understanding how the behaviour of fund managers may result in competitive return chasing and lower risk aversion during good times.

For the purpose of this analysis, it can be assumed that i^* and r^* are given, so that the expression for the optimal x becomes:

$$x_t^* = \frac{i_t - i_t^*}{\theta[V_t(i)]} \qquad (23)$$

If the pioneers I_0 are assumed to hold a fraction π of total initial wealth, then the demand for peso assets in period 0 and 1 respectively are given by:

$$K_0^0 = \pi w \frac{i_0 - i_0^*}{\theta[V_0(i)]} \qquad (24)$$

$$K_0^1 = \pi w \frac{i_1 - i_1^*}{\theta[V_1(i)]} \qquad (25)$$

Analogously, period 1 demand for peso assets by late investors is given by:

$$K_1^1 = (1-\pi) w \frac{i_1 - i_1^*}{\theta[V_1(i)]} \qquad (26)$$

It should be remembered that the superscript denotes the period in which the plan is formed and the demand expressed, while the subscript denotes the "cohort" to which investors belong, pioneers (period 0) or late (period 1).

The variance of the real return on peso assets is directly related to the variance of the exchange rate, as perceived by investors. This variance is in turn affected by the realisation of period 0 current account shock. Consider the case of a negative period 0 shock. Even if the negative shock is "small", in the sense that devaluation is expected to be suboptimal at time 2, the cut-off value for period 1 shock will be consequently smaller. Hence the probability that devaluation will turn out to be a desirable option increases; this in turn reduces desired holdings of peso assets via both a higher expected depreciation and a larger exchange rate variance. *A fortiori*, if the shock is so "large" that devaluation is made necessary, holding peso assets becomes undesirable, if not appropriately compensated by larger returns.

In this setup, the assumption that capital is invested in liquid assets, i.e. it is short term, and can thus be easily and promptly repatriated, proves to be a potential source of instability. It can be shown that under some contingencies (relating to the size of the observed period 0 shock), the sustainability of the exchange rate peg may depend on the beliefs of investors about each other's response to the shock. The initial shock might be "mild", in the sense that it would not by itself (i.e. provided there's no panic on investors' side) push the required external adjustment so far as to force the Government to devalue[25]. Yet, investors' panic – in the sense that either early investors liquidate and repatriate their investments, or late comers fail to provide ongoing lending, or both - may eventually push the required external adjustment beyond the devaluation triggering critical level.

Assuming the shock is mild, in the above sense, if investors could co-ordinate on the "no panic" attitude, then no devaluation would be triggered, thus justifying *ex post* their behaviour. On the other hand, failure to co-ordinate would result in a currency crisis, which again would *ex post* justify panic. Hence, there may be two equally rational equilibria, one "good" with no capital flight and ongoing lending, and one "bad" with capital flight and ongoing lending failure.

This instability is inherent to the structure of the market, with particular respect to the short term nature of capital flows, those in particular that result from portfolio diversification strategies and the desire to chase the high returns offered by emerging markets' assets during booming periods. Furthermore, early investors' re-optimisation of their portfolio, in response to the observed shock, is easily seen to potentially worsen the likelihood that instability arises.

The above discussion presumes the possibility of identifying some "mild" range for the initial shock in which multiple equilibria arise which depend on investors' beliefs about each other's resolve – to stay or leave (if pioneers) and to enter or keep out (if late comers). The identification of the relevant conditions on the size of the shock is the subject of next section.

[25] For example, the "mild shock might be represented in figure 1 by a shift from the initial adjustment constraint (i.e. the one passing through the origin) to the one indicated by $X_2<X^c$.

2.3 Three scenarios

The above discussion can be summarised by defining three possible scenarios. Let us recall that, given the exchange rate at time 0 is fixed at the level which equilibrates the current account, ε_0 is the current account surplus in period 0 and the expected surplus in period 1. For simplicity, let's assume that ε_0 is negative (so that the domestic economy runs a current deficit).

It is also useful here to define $\underline{R}$ as the initial lever of foreign exchange reserves. Interpreting $\underline{R}$ as the level of actual reserves held by the Government, means ignoring the possibility that she could borrow reserves in case of need (for example by accessing IMF lending). On the other hand, $\underline{R}$ may include a contingent credit line. It will be shown later that allowing the Government to borrow reserves can isolate the economy from instability. This points in favour of an international lender of last resort.

Another useful reminder is reporting equation (19) in rearranged terms, i.e.:

$$X^c - \underline{X} = -\frac{\gamma}{\beta} C\sqrt{\beta^2 + \gamma^2 z} \qquad (19')$$

Recall that X is the autonomous (random) component of the current account and $\underline{X}$ is its value before period 0 shock. X^c is the level of X_2 which triggers the decision to devalue: for cumulative (negative) shocks exceeding (in absolute value) $X^c - \underline{X}$, it is optimal for the Government to adjust by using a mix of deflation and devaluation[26]. $X_2 - \underline{X}$, is the current "surplus" which would be run in period 2 (actually a deficit, if negative) if no adjustment were undertaken; given that it is required that period 2 current account be in balance, it is also the size of the adjustment to be carried out at period 2.

Finally, a simplifying assumption must be made about the reaction of investors to fears of devaluation. It is assumed that either investor's desired peso assets holdings fall to zero if she expects a devaluation to occur, be it as a necessary policy consequence of period 0 shock or the result of the other investor panic.

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[26] Recall that given the assumed non reverting process for X_t and the assumption that ε_2 is zero, $X_2 - \underline{X}$ is equal to $\varepsilon_0 + \varepsilon_1$ (see equation 3), and $X^c - \underline{X}$ is the critical size for the cumulative shocks.

CASE 1) The first step consists of identifying the values for ε_0 which trigger a devaluation by themselves, i.e. even though there's no external pressure from the capital account side. The range is defined according to the following inequality:

$$2\varepsilon_0 < \left(X^c - \underline{X}\right) = -\frac{\gamma}{\beta} C\sqrt{\beta^2 + \gamma^2 z} \qquad (27)$$

which is equivalent to

$$\varepsilon_0 < \frac{-\frac{\gamma}{\beta} C\sqrt{\beta^2 + \gamma^2 z}}{2} = \varepsilon_L \qquad (27')$$

The left hand side of (27) is the expected current imbalance which period 2 is expected, after the realisation of ε_0, to inherit from previous periods shocks (recall that ε_0 is period 0 current "surplus" and also period 1 (and 2) expected "surplus", given zero expected period 1 shock and the non reverting nature of the current account[27]. This case is trivial: the shock is so large that the expected period 2 adjustment exceeds the critical level, which makes devaluation the unique, unavoidable outcome. For values of ε_0 lower than ε_L, both representative investors expect an immediate capital loss from devaluation, irrespective of their beliefs about each other's behaviour. It is important to note that availability of reserves plays no role in (27); this follows from the interpretation of period 2 current account balance as a steady state equilibrium condition. Allowing reserves to mitigate the required adjustment would be equivalent to assuming that in an infinite horizon framework a limited amount of reserves could finance an external imbalance indefinitely.

CASE 2) Under this case, the range of shock values for which no crisis occurs, either as a consequence of a necessary policy adjustment or as the result of panic. Contrarily to case 1, here the level of accumulated reserves can contribute in a decisive way to the final outcome. In fact, even if the shock is smaller (in absolute value) than the above critical level, the capital account in period 2 might turn negative, and the reserves level might prove insufficient to finance the capital drain. That might force devaluation is in no contradiction with the fact that adjustment is a steady state requirement, even if any negative capital account can only be a temporary phenomenon. The domestic authorities have to find the foreign currency to finance both current and capital imbalances, however temporary, and they must adjust the domestic economic conditions to this end. Capital flight might then push the required adjustment so far that the Government decides to let the currency float.

Investors' failure to co-ordinate eventually causes the unnecessary currency devaluation.

What range of values for period 0 shock ensures that no panic can ever occur? In order to answer this question it is necessary to consider, in turn, the perspective of each investor under the "worst" assumption about the behaviour of the other (i.e. total repatriation if the other is the early investor, zero ongoing lending if she is the late investor). This is done in A and B below.

A) Let's start with pioneers. Their decision to keep money invested in peso assets (after the portfolio adjustment following re-optimisation) is independent of the resolve of late investors if, and only if, provided inequality (27) holds, the eventual reserves shortage is not sufficient to force adjustment beyond the critical level, defined by equation (19'). This is the case if:

$$2\varepsilon_0 + \left[\left(K_0^1 - K_0^0\right) + 2\varepsilon_0 + \underline{R} + K_0^0\right] > \left(X^c - \underline{X}\right) = -\frac{\gamma}{\beta} C\sqrt{\beta^2 + \gamma^2 z} \qquad (28)$$

In the left-hand side of (28), the first term is the (expected) adjustment required for bringing balance in the current account. The expression in square brackets is nothing but the (expected) shortage of reserves[28], obtained by summing up initial reserves ($\underline{R}$), the (expected) cumulative period 0 and 1 current "surplus" ($2\varepsilon_0$), period 0 capital inflows and period 1 capital outflows[29].

Inequality (28) can be conveniently simplified as follows:

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[27] See previous note.

[28] Note that in the discussion shortage of reserves is actually being assumed (which implies a negative square brackets term). If there was no shortage, then – given that this case assumes $\varepsilon_0 > (X^c - \underline{X})$ – no crisis could, *a fortiori*, arise. The relevant conditions for there being a shortage are given later in the section.

$$\varepsilon_0 > \frac{-K_0^1 - \underline{R} - \frac{\gamma}{\beta} C\sqrt{\beta^2 + \gamma^2 z}}{4} = \varepsilon_H^0 \qquad (28')$$

(28') defines the range of period 0 shocks which, from the perspective of early investors, ensures no crisis. ε_H^0 denotes the lower bound for the above (infinite) interval, and superscript "0" indicates that it refers to category of investors' perspective.

B) Turning to late investors' perspective, the reasoning is analogous to the one done under A. Late investors expect to be safe, even assuming total early capital repatriation, if:

$$2\varepsilon_0 + \left[2\varepsilon_0 + \underline{R} + K_1^1\right] > \left(X^c - \underline{X}\right) = -\frac{\gamma}{\beta} C\sqrt{\beta^2 + \gamma^2 z} \qquad (29)$$

Rearranging (29) yields:

$$\varepsilon_0 > \frac{-K_1^1 - \underline{R} - \frac{\gamma}{\beta} C\sqrt{\beta^2 + \gamma^2 z}}{4} = \varepsilon_H^1 \qquad (29')$$

The interpretation of the above inequalities is similar to that given, previously, for (28) and (28').

Both values for ε_H^0 and ε_H^1 are clearly negative. However, it cannot be said *a priori* whether either or both are larger or smaller than ε_L. As pointed in footnote 3, the analysis becomes interesting only if the authorities actually face a shortage of reserves, which is equivalent to requiring that ε_H^0 and ε_H^1 are larger (i.e. closer to zero) than ε_L. This is the case if the following inequalities are satisfied:

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[29] Recall that this is the perspective of pioneers, who are assuming the "worst scenario" in which late investors do not provide any ongoing lending.

$$\varepsilon_H^0 = \frac{-K_0^1 - \underline{R} - \frac{\gamma}{\beta} C\sqrt{\beta^2 + \gamma^2 z}}{4} > \frac{-\frac{\gamma}{\beta} C\sqrt{\beta^2 + \gamma^2 z}}{2} = \varepsilon_L \tag{30}$$

$$\varepsilon_H^1 = \frac{-K_1^1 - \underline{R} - \frac{\gamma}{\beta} C\sqrt{\beta^2 + \gamma^2 z}}{4} > \frac{-\frac{\gamma}{\beta} C\sqrt{\beta^2 + \gamma^2 z}}{2} = \varepsilon_L \tag{31}$$

After rearranging, (30) and (31) are respectively equivalent to:

$$-K_0^1 - \underline{R} > -\frac{\gamma}{\beta} C\sqrt{\beta^2 + \gamma^2 z} = \left(X^c - \underline{X}\right) \tag{30'}$$

$$-K_1^1 - \underline{R} > -\frac{\gamma}{\beta} C\sqrt{\beta^2 + \gamma^2 z} = \left(X^c - \underline{X}\right) \tag{31'}$$

Once it is assumed that (30') and (31') hold, so that existence of a "mild" range in ensured, it only remains to establish which of ε_H^0 and ε_H^1 is larger. The smaller one, in fact, is the relevant lower bound for the range of period 0 shock's values, and consequently the upper bound for the mid range, i.e. the instability region. That this is true, follows from the (implicitly made) assumption that the two types of investors have common knowledge about each other's desired peso assets holdings, the state of the fundamentals (the period 0 current account) and Government preferences. Thus, if (say) $\varepsilon_H^0 > \varepsilon_H^1$, then early investors know that even if $\varepsilon_0 < \varepsilon_H^0$, so long as $\varepsilon_H^1 < \varepsilon_0 < \varepsilon_H^0$, late investors will provide ongoing lending and that this will suffice to keep the required adjustment to a sustainable level (in the sense that it does not exceed the critical level). An analogous reasoning applies if the opposite holds true, i.e. if $\varepsilon_H^0 < \varepsilon_H^1$.

It is the case that $\varepsilon_H^0 > \varepsilon_H^1$, if and only if:

$$\varepsilon_H^0 = \frac{-K_0^1 - \underline{R} - \frac{\gamma}{\beta} C\sqrt{\beta^2 + \gamma^2 z}}{4} > \frac{-K_1^1 - \underline{R} - \frac{\gamma}{\beta} C\sqrt{\beta^2 + \gamma^2 z}}{4} = \varepsilon_H^1$$

(32)

i.e. iff: $K_1^1 > K_0^1$

Having assumed identical utility functions for pioneers and late investors, (32) and (32') imply that the category of investors whose perspectives "dominate" (in the sense of determining the lower bound for the "safety" no-crisis range) is the one holding the largest share of total wealth, and which then has the largest demand for peso assets.

CASE 3) With conditions (30') and (31') in mind, it is possible to define the instability range as the one delimited by ε_L and the minimum between ε_H^0 and ε_H^1, i.e.:

$$\varepsilon_L < \varepsilon_0 < Min\left(\frac{-K_0^1 - \underline{R} - \frac{\gamma}{\beta} C\sqrt{\beta^2 + \gamma^2 z}}{4} ; \frac{-K_1^1 - \underline{R} - \frac{\gamma}{\beta} C\sqrt{\beta^2 + \gamma^2 z}}{4} \right) \qquad (33)$$

where $\varepsilon_L = \dfrac{-\frac{\gamma}{\beta} C\sqrt{\beta^2 + \gamma^2 z}}{2}$

(33) defines the range of values for ε_0 over which 2 rational equilibria coexist. There's a good equilibrium in which early investors carry out their marginal portfolio re-optimisation, but do not massively repatriate their capital, and at the same time late investors carry out their optimal plans, providing ongoing lending. But there's a second, worse equilibrium, in which pioneers completely repatriate their period 0 investments, and late investors fail to provide ongoing lending. The occurrence of a currency crisis eventually depends on whether the two representative investors manage to co-ordinate on the good equilibrium. This is the main point of this paper: a currency crisis may turn out to be self-fulfilling. However, contrarily to the typical self-fulfilling model, what ultimately determines multiplicity of equilibria in this set-up is not investors' concern about the

behaviour of the policy-maker, but their concern about the behaviour of each other. Here, eventually, the Government simply faces the external transfer consequences of investors' co-ordination failure.

It is worth stressing, once more, that the existence of such a "mild" shock range depends on whether (30') and (31') hold. The reason for this is straightforward. If either (30') or (31') does not hold, it means that the corresponding representative investor has such a large desired level of peso assets, that she can carry out her optimal investment plans independently of the other investor, whatever the shock – conditional on the it **not** being in the devaluation range.

Without necessarily aiming at any faithful representation of the reality, the question arises whether an instability range is likely to exist. This leads to the comparison between the relative sizes of steady state peso asset holdings (i.e. period 1 desired levels), plus initial reserves, and the critical current account adjustment. It sounds unlikely that the latter may dominate the former. This does not however make the present analysis worthless, and I give two reasons for this.

- First, the present model assumes that the domestic economy enters period 0 with no short term debt. Allowing for investors to start with positive holdings of short term peso assets would make the conditions for the existence of an instability range more likely, and more so the larger they are. This is because from either investor's perspective, the *worst* case - in which the other panics – is much *worse* if the latter can withdraw a large amount of outstanding debt.
- Furthermore, if the model were extended to include many (possibly infinite) investors, the size of each investor's demand for peso assets would virtually go to zero, thus giving them no command on the final outcome.

With the above points in mind, the next section is devoted to some simple comparative statics, in order to understand what factors contribute to making instability more or less likely to break the domestic scene.

2.4 Comparative statics and policy implications

A preliminary important point to note is that the above conditions, with respect to ε$_0$, are not in reduced form. In fact both K_0^1 and K_1^1 depend on ε$_0$, through its impact on the probability of a regime switch. Deriving a reduced form solution would require more structure in investors' choices, in particular with respect to the probability of a regime switch, which is outside the scope of this paper. This does not preclude deriving some unambiguous conclusions concerning the impact of the model's parameters on the likelihood that a shock pushes the economy into instability. That this is so follows from both K_0^1 and K_1^1 being inversely related to the probability of a regime switch, which makes them positive functions of ε$_0$.

The latter point is better explained in relation to the analysis of the impact that a larger fixed credibility cost (C^2) has on the identified ranges. Inspecting the expressions for ε_L, ε_H^0 and ε_H^1 reveals the following points:

1) ε_L is negatively related to C, so that a larger fixed cost implies a larger (in absolute value) negative shock is necessary to force a devaluation irrespective of the behaviour of investors. Hence the upper bound for the necessary devaluation region moves further from zero, which makes the event less likely. The extent to which it does so is given by the following derivative:

$$\frac{\partial \varepsilon_L}{\partial C} = -\frac{1}{2}\frac{\partial\left[\frac{\gamma}{\beta}C\sqrt{\beta^2+\gamma^2 z}\right]}{\partial C} = -\frac{1}{2}\left[\frac{\gamma}{\beta}\sqrt{\beta^2+\gamma^2 z}\right] < 0 \qquad (34)$$

which follows from the fact that all parameters are defined as strictly positive.

2) ε_H^0 and ε_H^1 are also negative functions of C, so that likelihood that a negative shock breaks the critical size required for multiple equilibria is also decreased by a larger C. If the Government who is more concerned about her own credibility, then a larger shock (in absolute value) must hit the economy to force her to devalue, so that the necessary devaluation becomes more unlikely. This reflects on the larger absolute size for the shock required to cause investors' worries about each other. These conclusions are true irrespective of the functional dependence of K_0^1 and K_1^1 on ε$_0$, assuming it is positive. In fact:

$$\frac{\partial \varepsilon_H^0}{\partial C} = -\frac{1}{4}\frac{\partial\left[K_0^1(\varepsilon_H^0) + \underline{R} + \frac{\gamma}{\beta}C\sqrt{\beta^2+\gamma^2 z}\right]}{\partial C} \Rightarrow$$

$$\Rightarrow \frac{\partial \varepsilon_H^0}{\partial C}\left(1 + \frac{1}{4}\frac{\partial K_0^1(\varepsilon_H^0)}{\partial \varepsilon_0}\right) = -\frac{1}{4}\frac{\partial\left[\underline{R} + \frac{\gamma}{\beta}C\sqrt{\beta^2+\gamma^2 z}\right]}{\partial C} \Rightarrow \tag{35}$$

$$\Rightarrow \frac{\partial \varepsilon_H^0}{\partial C} = -\frac{1}{4}\left(1 + \frac{1}{4}\frac{\partial K_0^1(\varepsilon_H^0)}{\partial \varepsilon_0}\right)^{-1}\frac{\gamma}{\beta}\sqrt{\beta^2+\gamma^2 z} < 0$$

where the inequality follows, again, from the parameters' sign plus the fact that K_0^1 is increasing in ε_0. Similarly, the derivative of ε_H^1 is negative, as given by the following expression:

$$\frac{\partial \varepsilon_H^1}{\partial C} = -\frac{1}{4}\left(1 + \frac{1}{4}\frac{\partial K_1^1(\varepsilon_H^0)}{\partial \varepsilon_0}\right)^{-1}\frac{\gamma}{\beta}\sqrt{\beta^2+\gamma^2 z} < 0 \tag{36}$$

In a similar way, it could be shown that ε_L, ε_H^0 and ε_H^1 are all negatively related to z, the weight attached to real exchange rate deviations from target in the policy loss function. The interpretation is straightforward: the larger the Government's concern about exchange rate deviations, the less inclined she is to use it as an adjustment instrument.

The size of the instability range is easily seen to be larger, the larger C or z. In fact, ε_L is shifted more to the left than either ε_H^0 or ε_H^1, and to a factor of $2\left(1 + \frac{1}{4}\frac{\partial K_1^1(\varepsilon_H^0)}{\partial \varepsilon_0}\right)$. Hence, while the likelihood that "something may go wrong" is unambiguously smaller, if either C or z are larger, whether the probability that instability arise is actually made larger or smaller depends on the shape of the density function of the random shock.

Different considerations matter in defining, qualitatively, the credibility of the commitment to a predetermined exchange rate regime. Because, especially in Latin American Countries, such regimes have been set up in order to provide the system with a nominal anchor and reduce inflation, larger costs of disinflation make the commitment more credible. Also, the degree of "technical" irreversibility is very important; as noted by Mishkin and Savastano (2000), two types of highly irreversible ("hard") pegs are those implied by a currency board and by full dollarisation[30]. In the former, where the domestic currency is backed 100% by a foreign ("anchor") currency; the commitment has a legal backing; in the latter, the domestic currency is eliminated and substituted with the foreign one. Although abandoning either of the above systems entails large costs, yet they do not completely isolate a Country from speculative attacks (as shown by the Argentine experience in the aftermath of the Mexican crisis); they may emerge as a result of a large negative shock raising doubts about its sustainability, or fears of confiscation or limits to repatriation of capital. Furthermore, hard pegs imply a complete loss of control on monetary policy, which leaves no scope to alleviate the output effects of large adverse demand shocks. It is not easy to say how much of the success in eliminating pressure on the argentine peso in 1995; the strong commitment of a currency board could well have played a role, alongside with a healthy banking system and proper policy measures, helped by the substantial injection of multilateral institutions funds.

The impact of a larger initial level of reserves on ε_H^0 and ε_H^1 is also negative, but reserves are irrelevant to ε_L. This reflects the previously discussed fact that reserves cannot be used to postpone adjustment, while lack of sufficient reserves to cover a negative capital account may eventually force a non necessary devaluation. This is an important point, because if the possibility for the Government to access an external source of reserves is introduced, then the level of initial reserves can be made arbitrarily large; by pushing ε_H^0 and ε_H^1 to the left of ε_L, this can rule out instability. Intuitively, in order for such a credit line to be effective in this respect, investors must believe that it is made promptly and unconditionally available to the economy eventually suffering the pressure of instability. This leads to the desirability of a lender of last resort for Countries experiencing a temporary self-fulfilling liquidity drain.

The remaining predetermined variable in the model is K_0^0, i.e. the level of period 0 desired peso assets – and, having excluded zero initial peso assets holdings, the level of period 0 capital inflows. As it does not appear in the expressions for $\varepsilon_L, \varepsilon_H^0$ and ε_H^1, it can be concluded that it is irrelevant to the likelihood of either the unique bad equilibrium or instability. As previously noted, allowing a positive level of initial short term debt would make instability more likely, more so the larger such level. But even in the latter case, K_0^0

[30] Argentina has a currency board system since 1991; Panama is an example (the only one in Latin America) of a fully dollarized economy.

would be irrelevant. One way in which K_0^0 could matter is through its eventual impact – not modelled here – on the size of the shock itself. It is often argued that large capital inflows may drive the domestic adsorption on an expansionary path, by inflating domestic assets, releasing more credit to the private sector, and by appreciating the real exchange rate. Intuitively, these feed-back (negative) effects on fundamentals make large initial capital inflows less desirable, although lower initial capital flows are likely to be associated – ceteris paribus - with lower period 1 desired peso assets, as they both share the same determinants (e.g. the level of total wealth and the degree of risk aversion).

The analysis in this paper highlights the role of short-term borrowing and the speculative nature of capital flows. Investments, both first and second period ones, were assumed to be in liquid assets, although means of a long-term portfolio diversification strategy. It is precisely this feature, plus the desire to adjust their portfolio to adverse, though mild, economic developments, that creates the potential for instability. If K_0^0 was reformulated to be a two period illiquid investment, the perverse results previously obtained would fail to hold, as no repatriation of early investments would be allowed. Table 1 below reports facts about some key macroeconomic conditions in Mexico, Korea, Indonesia and Thailand, i.e. the crisis Countries; for the sake of comparison, Argentina, Chile and Malaysia are also included as cases of heavy external borrowers, in the same Regions, which escaped collapse.

Tab.1 Macroeconomic indicators in the years prior to financial crises

		Mex	Arg	Chile	Thai	Kor	Ind	Mal
1*	Sh-t debt (ml $)[a]	36257	8653	4130	37613	65680	32230	11068
2	% of GNP	9.2679	3.3982	9.4491	21.2993	13.6725	14.5655	11.7044
3**	Portfolio (ml $)[b]	55714	28928	1721	16329	52090	14594	-4269
4	% GNP	4.2667	4.2083	1.1881	1.8234	2.0907	1.3246	-0.953
5*	CA (%GNP)[a]	-7.582	-3.973	-3.626	-8.32	-4.789	-3.463	-4.86
6*	Res (%GNP)[a]	6.4669	6.0871	23.7233	21.8837	7.1106	8.7655	29.4957
7*	Res (%GNP) 89[c]	1.7088	1.3105	10.6662	6.0823	3.3719	2.9592	9.2129

Sources: *World Bank, Global Development Finance (1999) , **IMF, Balance of Payments Statistics Yearbook (1997 and 1999)

[a]1993 for Mex, Arg, Chile; 1996 for Thai, Kor, Ind, Mal [b]Cumulative: 90-93 for Mex, Arg, Chile; 90-96 for Thai, Kor, Ind, Mal

[c]1989 Res in % of: GNP-1993 for Mex, Arg, Chile; GNP-1996 for Thai, Kor, Ind, Mal.

The first row shows the level of short term debt in the year prior to the one in which the first signs of a crisis were perceived (1994 for the Latin American and 1996 for the Asian Countries); the second row expresses it as a percentage of GNP in that year. It appears that all crisis Countries had a substantial amount of short term obligations, ranging from 9% in Mexico to 21% in Thailand; an exception is Argentina , with a figure as low as 3%. Short term debt, however, do not entirely capture the whole amount of short term-speculative capital flows, as they exclude portfolio flows which in some cases have also been quite large; cumulative portfolio flows, between 1990 and the pre-crisis year, are reported in the third row (the fourth shows their yearly average value in percent of GNP). Mexico received portfolio flows for an average 4% of GNP, a figure similar to that for Argentina; Korea and Thailand also were large portfolio capital importers, with around 2% of GNP. Indonesia and Chile have has a lower percentage (1.3 and 1.2 respectively), while Malaysia experienced an average net outflow. Hence, in Chile and Malaysia relatively low portfolio flows somehow compensate for the substantial accumulation of debt; the opposite is true of Argentina. A more complete picture can be gained by looking at the size of the current account imbalance and at the level of reserves in the year prior to the crisis: those values are shown, respectively, in rows 5 and 6, as percent of pre-crisis GNP. All Countries had a current deficit; the 8% of Mexico and Thailand are striking, but no one had a deficit of less than about 3.5%. With respect to reserves, the figures are impressive for Thailand, Chile and Malaysia (with more than 20% of GNP in the year prior to crisis); however, as row 7 shows, it is only in Chile and Malaysia that the level of reserves (shown in percent of pre-crisis GNP) was high in 1989, i.e. just before the large wave of private flows of the 90s.

Although no single indicator neatly discriminates among crisis and non-crisis Countries, taken together the facts illustrated seem to indicate that the ones where a crisis actually emerged are those more vulnerable in terms of a combination of external imbalance (current account), accumulated short term liabilities and foreign reserves. Argentina stands somehow in the middle, with a picture similar to Mexico – but half its current account deficit; in fact, it was the first and most heavily hit by contagion in 1995. As previously noted, the credibility of its currency regime, a sound banking system and the prompt foreign assistance are among the facts which may explain the success of its defense.

Given the importance of the accumulation of short term liabilities in the system, a trivial policy implication relates to the scope for stricter regulation or the provision of disincentives aimed at discouraging short-term flows. As argued by Cordella (1998), this may reduce perceived instability and uncertainty over future outcomes, which in turn may stimulate more long-term investments. Chilean extensive controls on short term capital inflows are often quoted as a successful policy towards reducing the risk of a financial crisis. It should be noted, however, that the evidence on the effectiveness of capital control measures in reducing the volume of short term capital flows is only mixed; those measures appear to be successful on impact, but less so in the medium to long run[31].

As discussed in the introduction, the literature has raised the following objection to models that exhibit multiple equilibria and the possibility of self-fulfilling crises: they do not specify what co-ordinates agents' expectations and determines the final outcome, among the many possible. As noted, with a few exceptions the existing literature does no more than resorting to sunspots or focal points as co-ordinating devices. While these explanations are often blamed as *ad hoc* and economically meaningless[32], some stylised evidence appears to support them. In many of the recent crises, some major events appear to have had disruptive consequences on market sentiment, be it an external economic development, an important political event or the failure of a large institution[33].

The present model suffers the same shortcoming as other self-fulfilling models. If the initial shock falls in the "mild" range, than nothing says what determines which outcome eventually prevails. In my opinion, however, it is much more sensible to think of a co-ordination failure among different investors, equally concerned about the value of their respective investments, rather than of a representative agent suddenly expecting the domestic authorities to abandon an exchange rate regime. Furthermore, in this model a fundamental shock is assumed to break the scene and to raise investors' concern. Intuitively, it may also be possible to look for a co-ordinating device in the developments of the domestic assets market - once the model is translated in an ideal infinite horizon-continuous time version and some noise is introduced which makes inference about each other's behaviour from asset prices evolution subject to uncertainty.

[31] See Edwards (1996 and 1998). Edwards (1998) also investigates the effect of the imposition of capital controls on the dynamic responses of domestic interest rates to foreign interest rates shocks and of the real exchange rate to capital inflows, and finds little evidence of any significant effects.

[32] See, among others, Davies and Vines (1995).

4. Conclusions

This paper develops a three period model to show how a “non necessary” currency crisis may be determined by an investors’ driven form of instability. Capital flows are assumed to result from international portfolio adjustment. The latter is not instantaneous, and is carried out by two heterogeneous categories of investors (early and late), who enter the domestic market at two different stages (time 0 and 1). The Government, who minimises a welfare loss function depending positively on output deflation and exchange rate devaluation, is assumed to face an adjustment problem involving the use of a linear combination of deflation and devaluation. In addition, she is assumed to bear a fixed credibility cost in case a devaluation is engineered.

The analysis has shown how the inability of existing and prospective investors to co-ordinate their actions may generate a currency crisis as the result of a switch between two equally rational equilibria: a “good” one in which pioneers do not repatriate their capital and ongoing lending takes place (and no devaluation is triggered), and a “bad” one in which capital flight and failure to provide ongoing lending to force devaluation. The behaviour of the two representative investors crucially depends on the conjectures they hold about each other’s strategy (stay/exit for the pioneer, enter/not enter for the late investor). Devaluation is triggered - if expectations of the bad equilibrium prevail - because too big a capital account external transfer adds to the initial “innocuous” shock for the Government to fulfil her commitment to the fixed exchange rate.

The possibility of multiple equilibria, however, arises only for realisations of period zero shock included in a “mild” range of values. The severity of the negative shock needed to expose the economy to the risk of instability is found to be a positive function of: the initial level of foreign exchange reserves, the bias of Government preferences against devaluation (relative to output deflation) and of the value of her commitment to the fixed exchange rate regime.

Although the current account has been assumed initially balanced, it is clear that the chances of a fixed exchange rate regime to survive are larger if the Country has strong fundamentals to start with (here this means a net current position as close to balance as

[33] For example, confidence in Mexico was hardly hit by the US niterest rate rises and by political turmoil following the Colisio murdering early in 1994.

possible). This creates room for fundamental negative shocks to hit without forcing a devaluation or generating the risk of instability.

In setting the above dynamics, a crucial role is played by the short-term nature of capital flows. If investment was reformulated to be in long-term assets, than the possibility of multiple equilibria would disappear. Also, the same result could be obtained by allowing the domestic authorities to access a sufficiently large line of contingent credit, to be added to accumulated reserves in eventually financing the panic-led capital outflow. This would suffice to free investors of any concern for each other behaviour in case of a "mild" shock. These observations clearly point in favour of measures aimed at altering the term structure of foreign capital inflows, with an obvious preference for less liquid ones. Also, they imply the desirability of an international lender of last resort, who is ready to finance short-run panic-driven capital account imbalances.

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